

data to the head end over another medium, such as a phone line or a cable modem, on the upstream channels. One example of a one-way wireless system is a Digital Satellite System (DSS) from DIRECTV.

A specific type of wireless broadband system communicates over Multichannel Multipoint Distribution Service (MMDS) frequencies and Multipoint Distribution Service (MDS) frequencies. The MMDS frequencies range from 2596 MHz to 2644 MHz. The MDS frequencies range from 2150 MHz to 2162 MHz. In a typical MMDS system, the bandwidth of the upstream channels is about 6 MHz. The upstream bandwidth is divided into subchannels. Each subchannel has a bandwidth of 200 kHz.

A head end manages the upstream and downstream channels with the customer. The head end also interfaces the customer with communication systems such as the Internet. The head end includes a base antenna comprised of a transmitter antenna and one or more receiver antennas. MMDS requires a line of sight between devices that are communicating. Therefore, the antennas are placed on a high building or a mountain to establish lines of sight with the customers.

The transmitter antenna is omni-directional and broadcasts data from the head end to the customers on the downstream channels. In a two-way wireless system, the receiver antennas are positioned to receive MMDS signals transmitted from customers to the head end on the upstream channels. Each receiver antenna is positioned to receive MMDS signals from customers located within a certain area. The areas formed by the antennas are referred to as sectors. The sectors have designated frequency ranges or designated channels.

The head end is comprised of an upstream manager and a downstream manager that control transmissions on the upstream channels and the downstream channels, respectively. As stated above, the upstream channels and the downstream channels are divided into subchannels. One upstream subchannel is a contention channel reserved for signaling, while the remaining subchannels are bearer channels.

In the wireless broadband system, a wireless broadband router is located at a customer premises. The wireless broadband router communicates with the upstream manager and the downstream manager to exchange data. The upstream manager generally operates the channels and/or subchannels in four states: idle, contention, polling, and dedicated. In the idle state, the channels are idle. In the contention state, the upstream manager generates and transmits control signals over one or more subchannels.

For the polling and dedicated states, the upstream manager polls numerous wireless broadband routers to allocate use of the subchannels.

Polling is a round robin process to determine which wireless broadband router has access to a subchannel. The upstream manager maintains a queue of the active wireless broadband routers to determine which wireless broadband router is next to transmit over a subchannel for a period of time. The upstream manager keeps an inventory of open subchannels and waiting wireless broadband routers in the queue.

The upstream manager uses a credit to grant a wireless broadband router use of a subchannel for a limited period of time. A credit is a message that allows usage of a subchannel for a period of time or for the transfer of a maximum number of transmission units, such as bytes. One example of a credit is information, such as a subchannel or frequency range, a maximum allowed time to transfer data, and a maximum number of bytes the wireless broadband router is allowed to transfer.

There are two kinds of credits: polling and dedicated. Polling credits are credits related to polling of the wireless broadband routers. Polling credits are generally smaller than the dedicated credits. Once the wireless broadband router completes transfer of the packets, the wireless broadband router transmits a DONE message to the upstream manager via the upstream channels. The DONE messages include information such as the number of bytes sent and the number of packets left for the wireless broadband router to transfer. If the DONE message shows that the wireless broadband router has more than three packets

left to transfer and there are available subchannels, then the upstream manager issues a dedicated credit to the wireless broadband router.

Fault Management Systems and Performance Management Systems

Two important areas in communication network operation are fault management and performance management. A fault management system assists in identifying faults in the communication network through the use of alarms and monitoring devices. Once the fault management system identifies the faults, network personnel can then fix, replace, or add communication devices or software. Two examples of fault management systems are eHealth from Concord Communications and NerveCenter from Veritas Software Corp.

A performance management system evaluates the performance of a communication network. The performance management system provides a clearer view of the operation of the communication network. The performance management system determines how a communication network is performing at all levels, such as nationally, regionally, and down to a specific communication device. Therefore, to improve performance, bottlenecks and high traffic points may be identified to add equipment or perform tuning on a specific communication device. By evaluating the performance, the performance management system can also shape the traffic over the communication network.

One prior performance management system provides an Internet service assurance to e-commerce businesses for their websites. This prior system manages the delivered quality of e-mail, news, web, domain name service, Radius, file transfer protocol, and lightweight directory access protocol service of e-commerce businesses. This prior system also provides management of service level agreements. Unfortunately, this prior system is focused on enterprise management and has not been effectively adapted for service management of a communication network. Also, this prior system does not provide performance management for operating a broadband wireless system.

Remote monitoring (RMON) probes monitor performance information of a communication network. The RMON probes are in the same location as service